US009544980B2

(12) **United States Patent**
Chou et al.

(10) **Patent No.: US 9,544,980 B2**
(45) **Date of Patent: Jan. 10, 2017**

(54) **DRIVING DEVICE AND ILLUMINATION SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/850,251**

(22) Filed: **Sep. 10, 2015**

(65) **Prior Publication Data**

US 2016/0205755 A1 Jul. 14, 2016

(30) **Foreign Application Priority Data**

Jan. 8, 2015 (TW) .... 104100487 A

(51) **Int. Cl.**

H05B 41/08	(2006.01)
H05B 41/295	(2006.01)
H05B 41/24	(2006.01)
H05B 41/298	(2006.01)

(52) **U.S. Cl.**

CPC ***H05B 41/295*** (2013.01); ***H05B 41/24*** (2013.01); ***H05B 41/245*** (2013.01); ***H05B 41/2983*** (2013.01)

(58) **Field of Classification Search**

CPC H05B 41/24; H05B 41/245; H05B 41/295; H05B 41/2983

See application file for complete search history.

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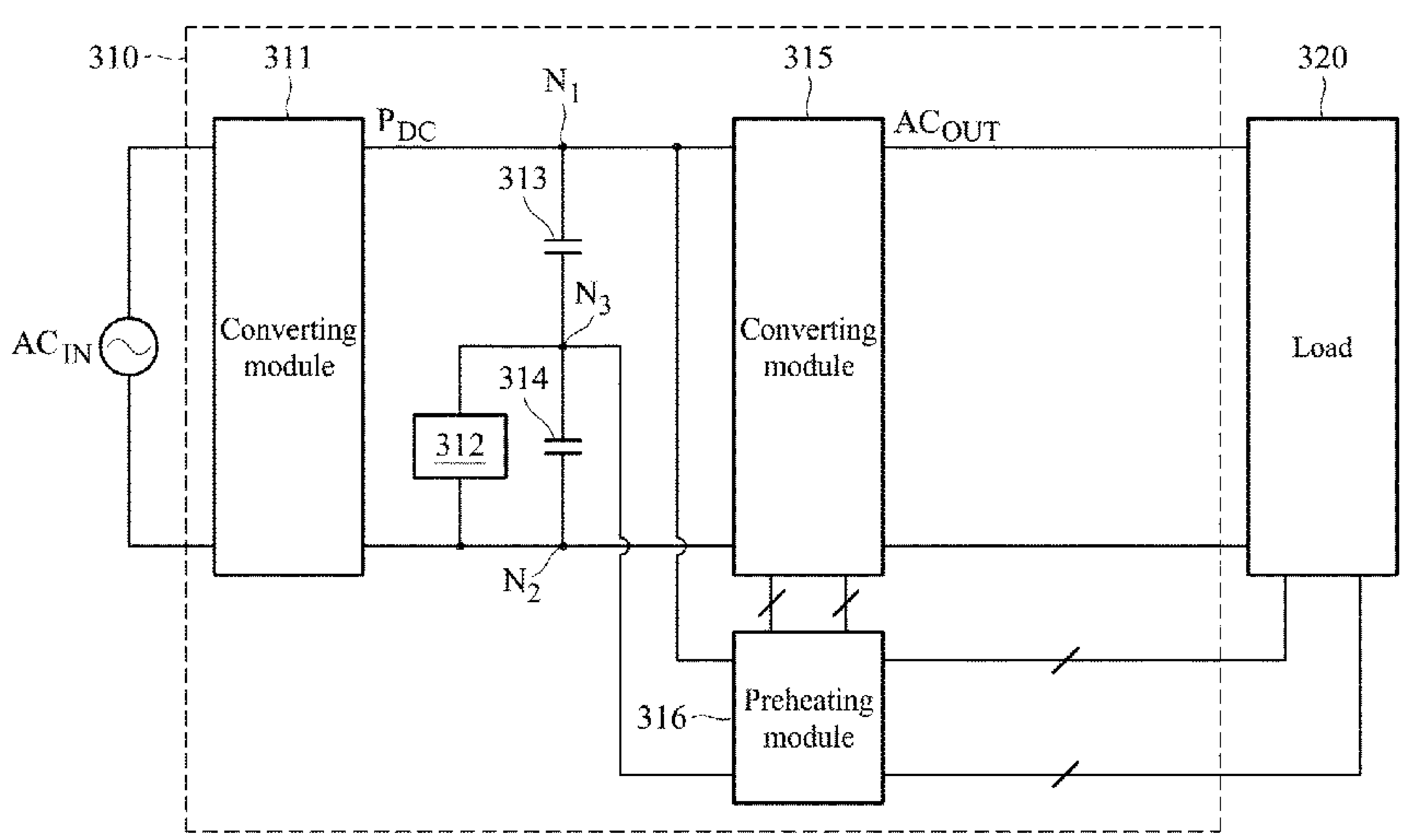
(57) **ABSTRACT**

A driving device provides output power to an illumination device including a plurality of filaments is provided. A first converting module converts input power into direct current (DC) power. The first converting module includes a pair of first input terminals receiving the input power and a pair of first output terminals coupled to a first node and a second node and outputting the DC power. A first capacitor is coupled between the first node and a third node. A second capacitor is coupled between the second and third nodes. The first clamping module is connected to a first specific capacitor in parallel. The first specific capacitor is the first capacitor or the second capacitor. A second converting module converts the DC power to generate the output power.

16 Claims, 6 Drawing Sheets



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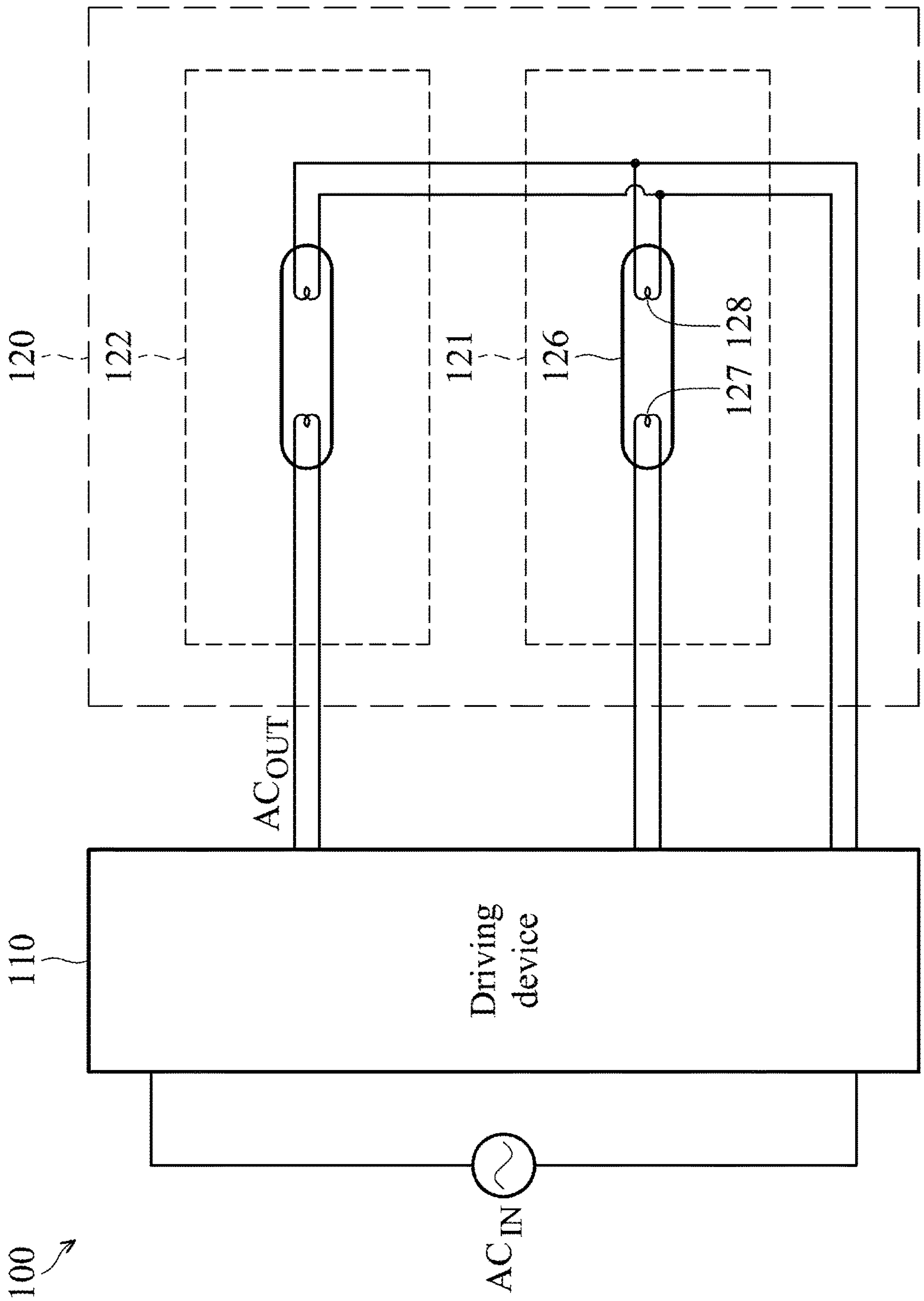

FIG. 1

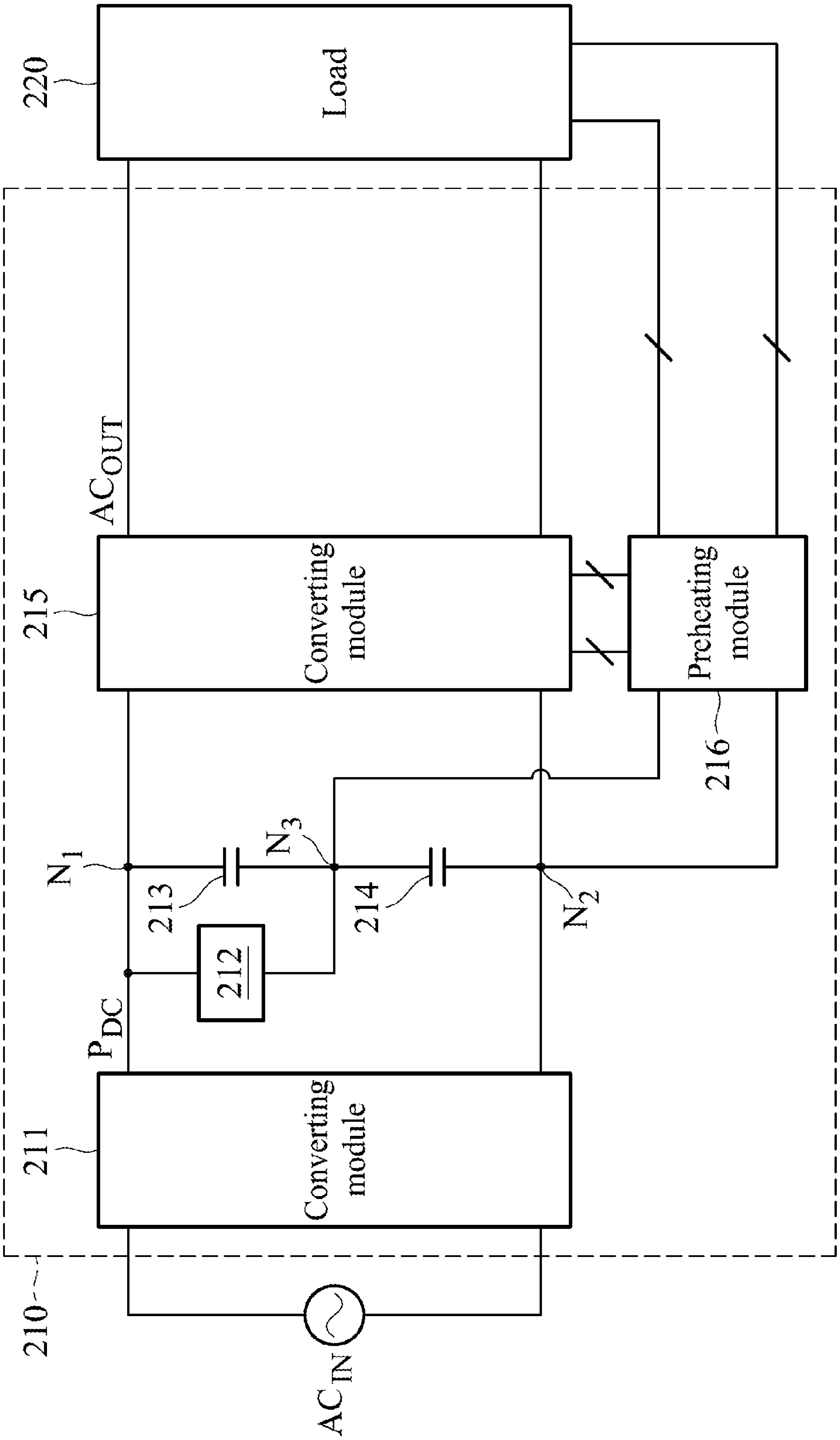
220
Load
215
Converting module
211
Converting module
Preheating module
216
210
212
213
214
N1
N2
N3
PDC
ACOUT
ACIN

FIG. 2

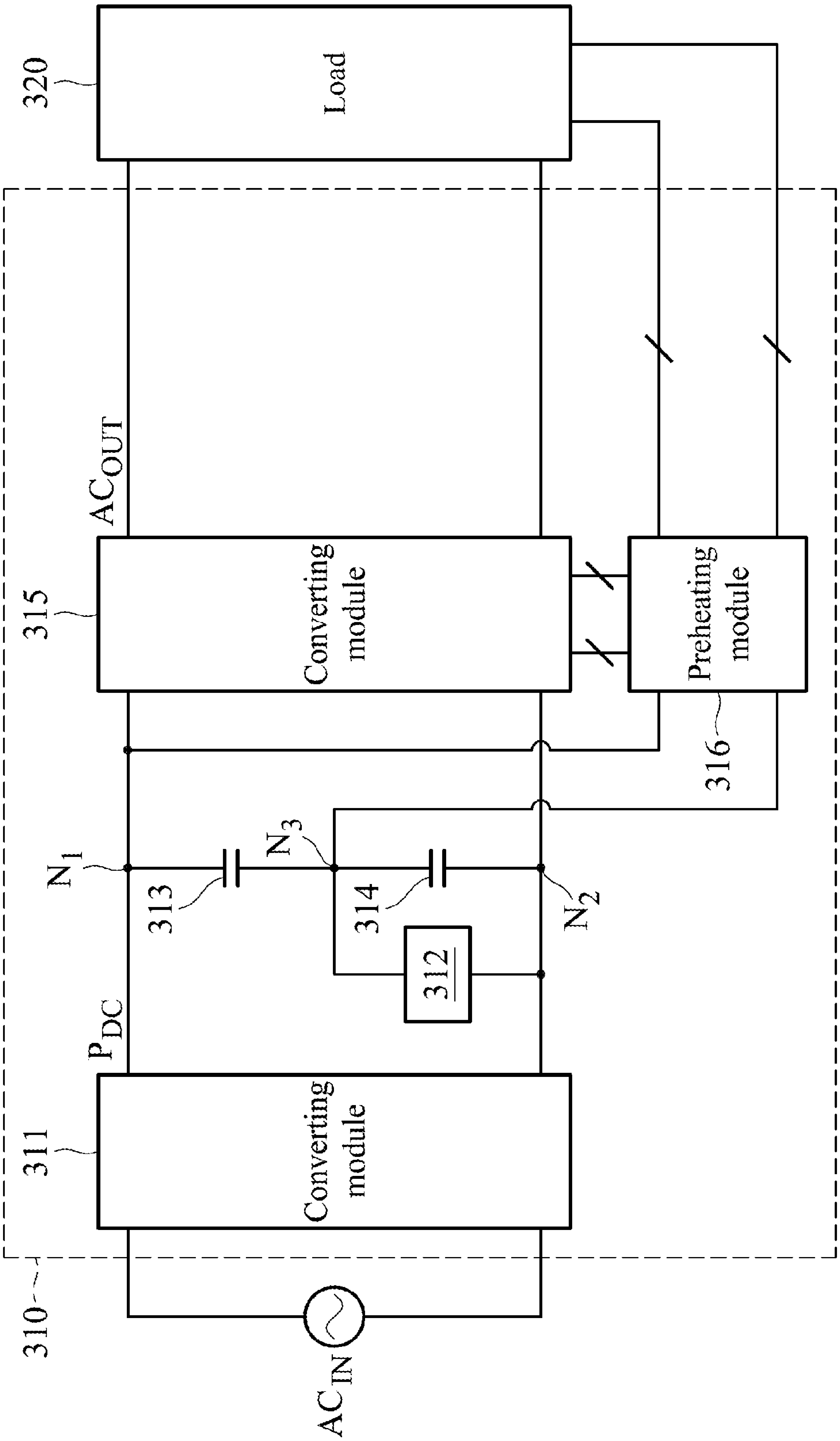
320
Load
315
Converting module
AC_{OUT}
Preheating module
316
N_1
N_3
N_2
313
314
312
P_{DC}
311
Converting module
310
AC_{IN}

FIG. 3

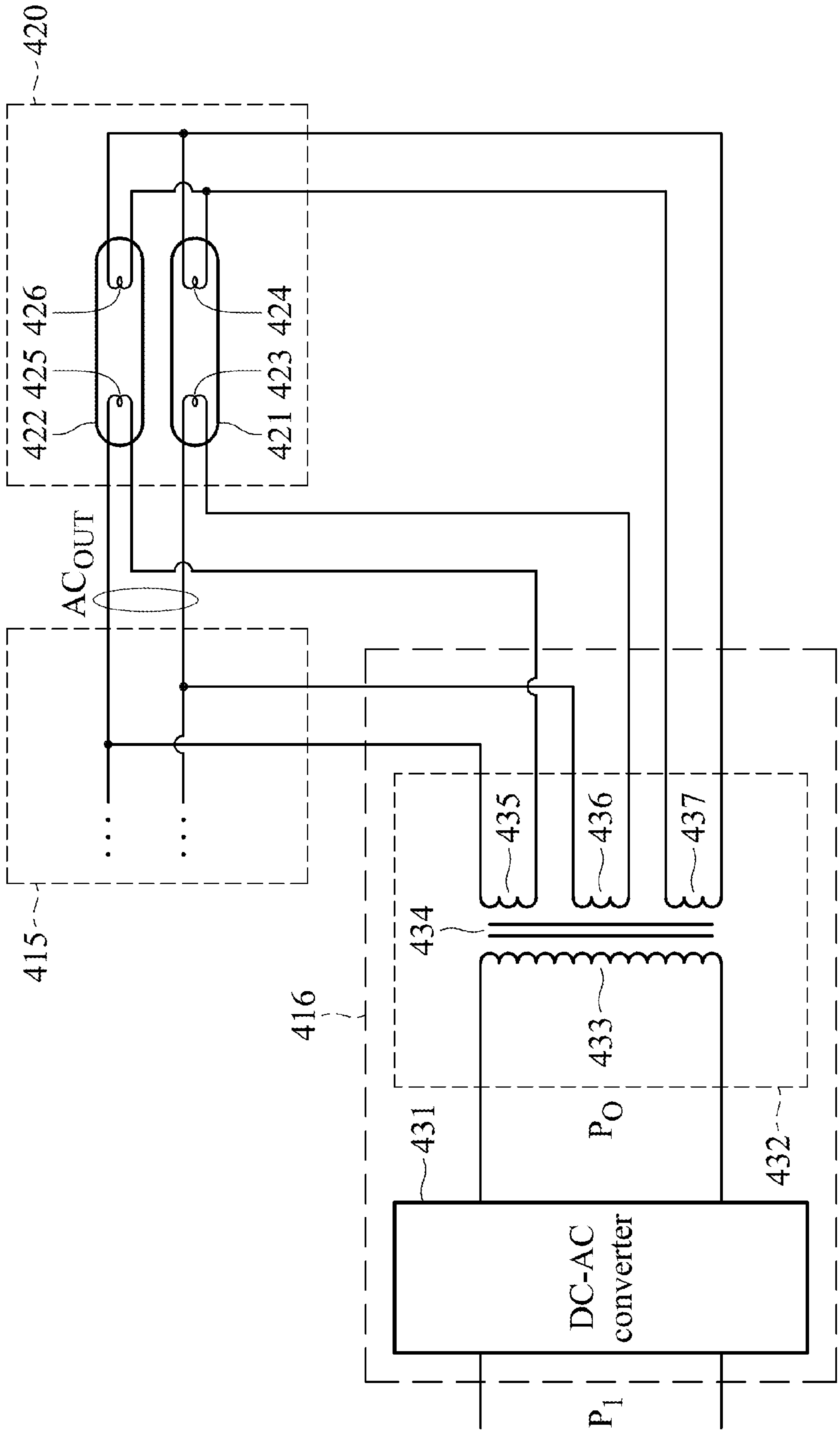
420
422 425 426
421 423 424
ACOUT
415
416
435
436
437
434
433
PO
431
432
DC-AC converter
PI

FIG. 4

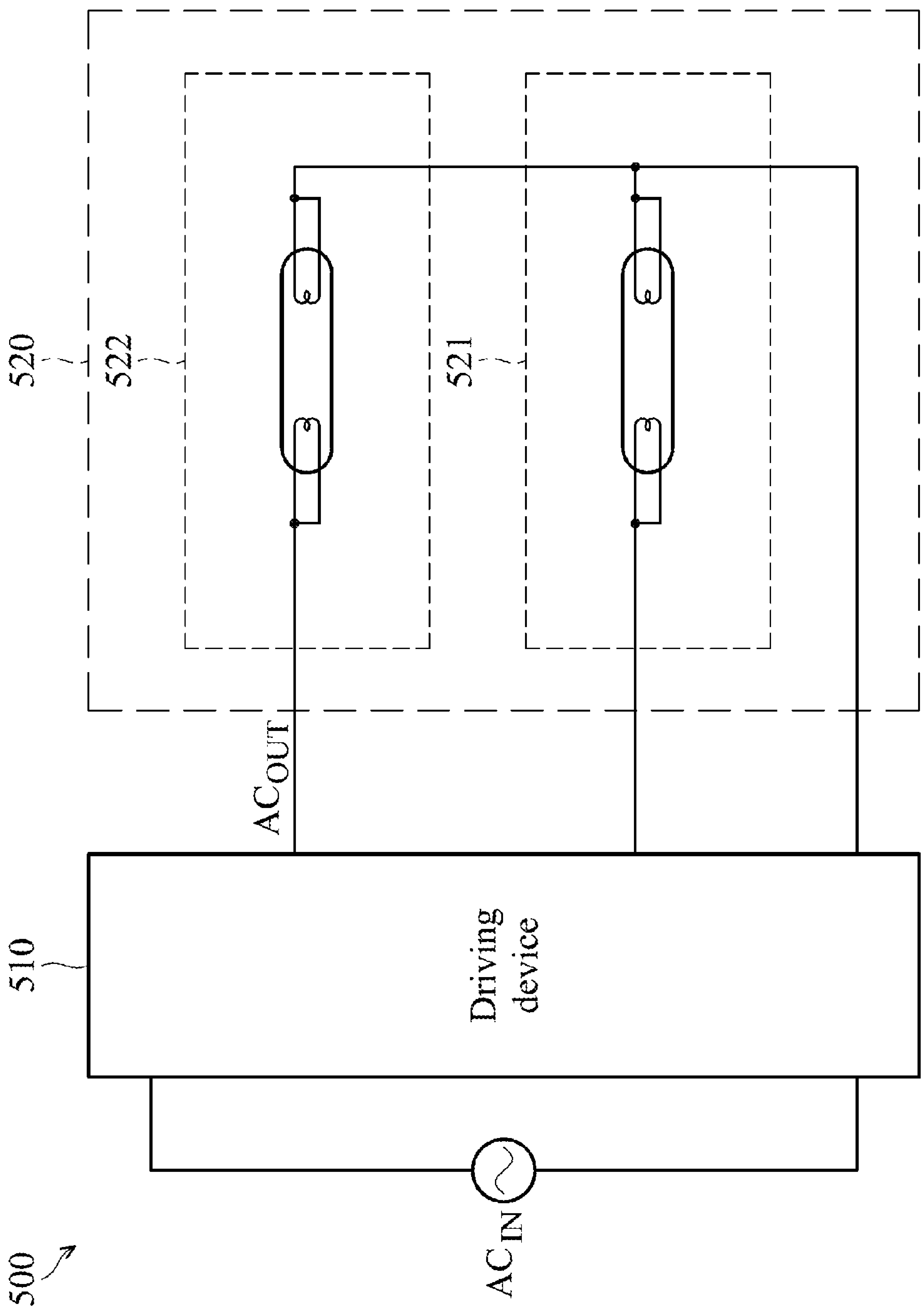

FIG. 5

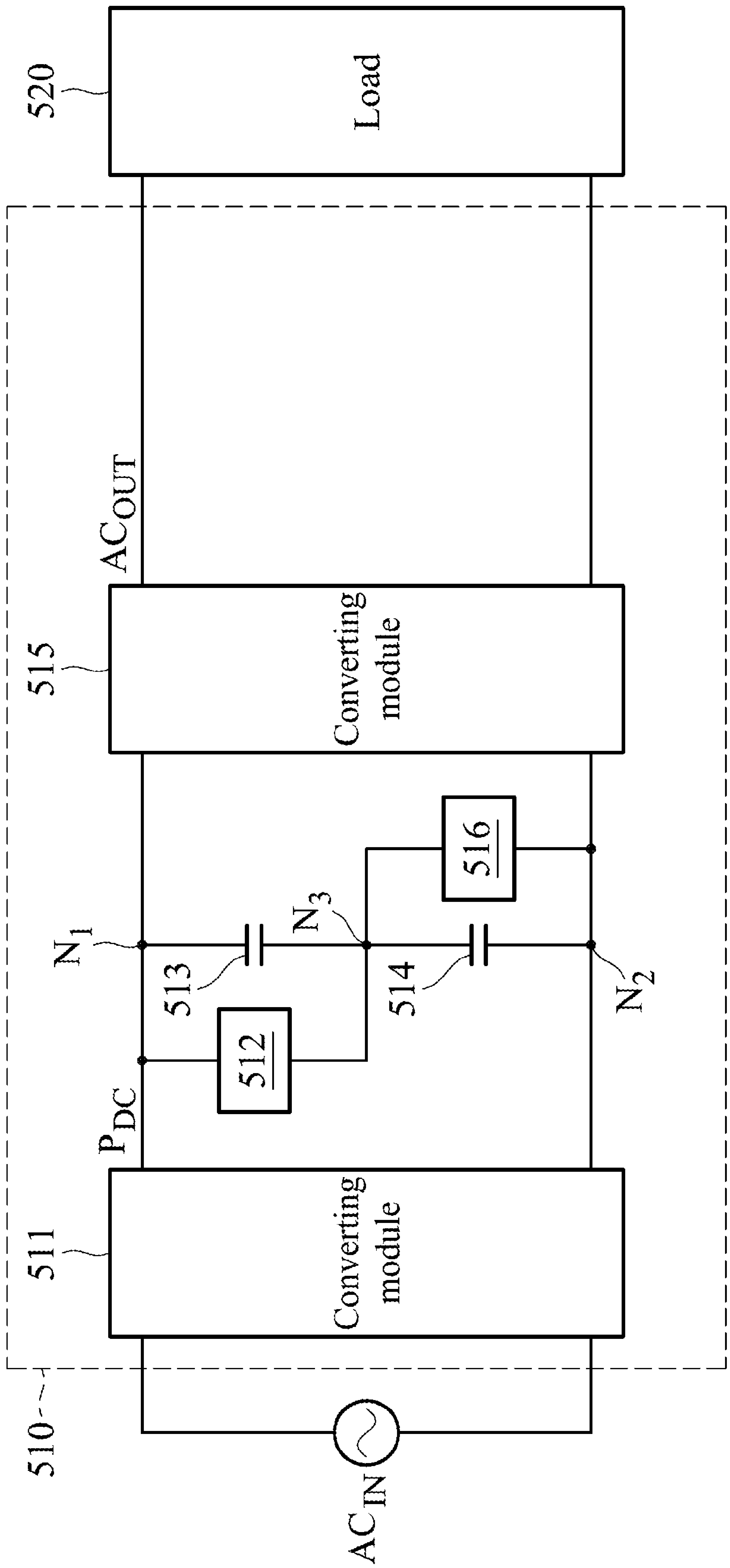
520
Load
515
Converting module
AC_{OUT}
516
N_3
N_1
513
514
N_2
512
P_{DC}
511
Converting module
510
AC_{IN}

FIG. 6

DRIVING DEVICE AND ILLUMINATION SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This Application claims priority of Taiwan Patent Application No. 104100487, filed on Jan. 8, 2015, the entirety of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a driving device, and more particularly to a driving device to light an illumination device.

Description of the Related Art

Illumination is a base requirement for people. In recent years, economic and trade activities and business activities are frequently held, and quality of home life is increased. The amount of electricity required for illumination is increased. Therefore, the power consumption of illumination is appreciable. Low-voltage, gas-discharge lamps are used widely. These lamps are referred to as fluorescent lamps.

BRIEF SUMMARY OF THE INVENTION

In accordance with an embodiment, a driving device provides output power to an illumination device comprising a plurality of filaments and comprises a first converting module, a first capacitor, a second capacitor, a first clamping module, and a second converting module. The first converting module converts input power into direct current (DC) power. The first converting module comprises a pair of first input terminals receiving the input power and a pair of first output terminals coupled to a first node and a second node and outputting the DC power. The first capacitor is coupled between the first node and a third node. The second capacitor is coupled between the second and third nodes. The first clamping module is connected to a first specific capacitor in parallel. The first specific capacitor is the first capacitor or the second capacitor. The second converting module converts the DC power to generate the output power. The second converting module comprises a second input terminal pair coupled to the first and second nodes and a second output terminal pair outputting the output power to turn on the illumination device.

In accordance with another embodiment, an illumination system comprises a first illumination device, a first converting module, a first capacitor, a second capacitor, a first clamping module, and a second converting module. The first illumination device comprises a plurality of filaments. The first illumination device is turned on according to output power. The first converting module converts input power into direct current (DC) power. The first converting module comprises a pair of first input terminals receiving the input power and a pair of first output terminals coupled to a first node and a second node and outputting the DC power. The first capacitor is coupled between the first node and a third node. The second capacitor is coupled between the second and third nodes. The first clamping module is connected to a first specific capacitor in parallel. The first specific capacitor is the first capacitor or the second capacitor. The second converting module converts the DC power to generate the output power. The second converting module comprises a second input terminal pair coupled to the first and second nodes and a second output terminal pair outputting the output power to turn on the illumination device.

A detailed description is given in the following embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be more fully understood by referring to the following detailed description and examples with references made to the accompanying drawings, wherein:

FIGS. **1** and **5** are schematic diagrams of exemplary embodiments of an illumination system, in accordance with some embodiments;

FIGS. **2-3** and **6** schematic diagrams of exemplary embodiments of a driving device, in accordance with some embodiments; and

FIG. **4** is a schematic diagram of an exemplary embodiment of a connection among a converting module, a preheating module and a load, in accordance with some embodiments.

DETAILED DESCRIPTION OF THE INVENTION

The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims.

FIG. **1** is a schematic diagram of an exemplary embodiment of an illumination system, in accordance with some embodiments. The illumination system **100** comprises a driving device **110** and a load **120**. The driving device **110** generates output power AC_{OUT} to drive the load **120** according to input power AC_{IN}. In this embodiment, the load **120** comprises illumination devices **121** and **122**, but the disclosure is not limited thereto. In some embodiments, the load **120** may comprise one or more illumination devices. The illumination devices **121** and **122** are continuously turned on according to the output power AC_{OUT}.

As shown in FIG. **1**, the illumination devices **121** and **122** are connected to the driving device **110** in parallel and are capable of operating independently. For example, when the illumination device **121** fails or is removed from the illumination system **100**, when the driving device **110** continuously provides the output power AC_{OUT}, the illumination device **122** can be turned on. Similarly, when the illumination device **122** fails or is removed from the illumination system **100**, the illumination device **121** can be turned on.

Since the operation of each illumination device **121** and **122** is the same, the illumination device **121** is used herein as an example. As shown in FIG. **1**, the illumination device **121** is a light tube **126** comprising filaments **127** and **128**. In one embodiment, before the driving device **100** provides the output power, the driving device **110** first preheats the filaments **127** and **128** to help the illumination device **121** to generate free electrons easily. Furthermore, when the light tube **126** is preheated, a light voltage across the light tube **126** can be reduced and the lift time of the light tube **126** can be increased. Therefore, before providing the output power AC_{OUT}, the driving device **110** is capable of turning on the illumination device **121** quickly. In another embodiment, the driving device **110** does not preheat the illumination device **121** but directly provides the output power AC_{OUT}. In this case, the illumination device **121** receives the output power AC_{OUT} to turn on. The invention does not limit the type of illumination device. In some embodiments, the illumination devices are bulbs. In one embodiment, the driving device **110** is capable of serving an electronic ballast having a filament-heating apparatus.

FIG. **2** is a schematic diagram of an exemplary embodiment of a driving device, in accordance with some embodiments. The driving device **210** comprises converting modules **211** and **215**, capacitors **213** and **214**, a clamping module **212**, and a preheating module **216**. The converting module **211** converts the input power AC_{IN} into a direct current (DC) power P_{DC}. In this embodiment, the converting module **211** comprises a pair of input terminals receiving the input power AC_{IN}. The converting module **211** comprises a pair of output terminals coupled to the nodes N_1 and N_2. In one embodiment, the input power AC_{IN} is an alternating current (AC) power and the peak-to-peak value of the AC power is approximately 347V. After the converting module **211** converts the AC power, the voltage level of the DC power P_{DC} is approximately 560V. In one embodiment, the converting module **211** is an AC-DC converter to convert AC power having a low frequency to DC power having a high frequency. In another embodiment, the converting module **211** has a power factor correction (PFC) function.

The capacitors **213** and **214** are serially connected between the nodes N_1 and N_2. As shown in FIG. **2**, the capacitor **213** is coupled between the nodes N_1 and N_3. The capacitor **214** is coupled between the nodes N_3 and N_2. In this embodiment, the capacitance values of the capacitors **213** and **214** are micro-farad. In one embodiment, the capacitance values of the capacitors **213** and **214** are higher than 22 uF. In other embodiment, the capacitors **213** and **214** are integrated into the converting module **211**. In some embodiments, if the converting module **211** originally has two capacitors connected between the nodes N_1 and N_2 in series, the capacitors **213** and **214** can be omitted.

The clamping module **212** is connected to the capacitor **213** or **214** in parallel to clamp the voltage across the capacitor **213** or **214**. In this embodiment, the clamping module **212** is connected to the capacitor **213** in parallel to clamp the voltage of the capacitor **213** and provides a charging path for the capacitor **214**. The invention does not limit the type of clamping module **212**. Any element or circuit can serve as the clamping module **212**, as long as the element or circuit is capable of clamping a voltage. In one embodiment, the clamping module **212** is a transient voltage suppressor (TVS), a surge absorber, or a metal oxide varistor (MOV). In some embodiments, if the converting module **211** originally has two capacitors connected between the nodes N_1 and N_2 in series, the clamping module **212** is connected to one of the capacitors in parallel.

The converting module **215** converts the DC power P_{DC} to generate the output power AC_{OUT}. As shown in FIG. **2**, the pair of the input terminals of the converting module **215** is coupled to the nodes N_1 and N_2 to receive the DC power P_{DC}. The pair of the output terminals of the converting module **215** provides the output power AC_{OUT} to light the load **220**. Since the internal structure of the load **220** is the same as that of the load **120**, the description of the load **220** is omitted. In this embodiment, the converting module **215** is a DC-AC converter to convert DC power with high voltage level to AC power with a high frequency.

The preheating module **216** is connected to the capacitor **213** or **214** in parallel. In this embodiment, since the clamping module **212** is connected to the capacitor **213** in parallel, the preheating module **216** is connected to the capacitor **214** in parallel. The preheating module **216** transfers the energy stored in the capacitor **214** to provide preheating energy to preheat the filament of the load **220**. When the preheating module **216** captures the energy stored in the capacitor **214**, since the clamping module **212** limits the voltage of the capacitor **213**, the voltage across the capacitor **213** is not too high. Therefore, a designer does not need to utilize a high voltage capacitor to serve as the capacitor **213**.

For example, assuming that the voltage level of the DC power P_{DC} is approximately 560V: Since the capacitor **213** is connected to the capacitor **214** in series, the capacitors **213** and **214** are charged, and the voltages of the capacitors **213** and **214** are approximately 280V. When the energy stored in the capacitor **214** is transferred to the preheating module **216**, since the voltage across the capacitor **214** is too low, the capacitor **213** is charged. However, the clamping module **212** limits the voltage across the capacitor **213**. In one embodiment, when the voltage across the capacitor **213** exceeds 300V, the clamping module **212** starts operating to stop charging the capacitor **213**. At this time, the clamping module **212** provides a charging path to charge the capacitor **214**. Therefore, the voltage of the capacitor **213** is not too high, and the voltage of the capacitor **214** can quickly be charged to 280V to supply the preheating module **216**. Since the voltages across the capacitors **213** and **214** are controlled, the voltages of the capacitors **213** and **214** are maintained.

Additionally, when the voltage of the capacitor **213** does not reach the turn-on voltage (e.g. 300V) of the clamping module **212**, the clamping module **212** does not operate. Therefore, there is no power consumption. Furthermore, the voltages of the capacitors **213** and **214** are controlled by the clamping module **212** such that capacitors pressuring high voltage are not required to serve as the capacitors **213** and **214**. Therefore, the cost of elements is reduced.

FIG. **3** is a schematic diagram of an exemplary embodiment of a driving device, in accordance with some embodiments. FIG. **3** is similar to FIG. **2** with the exception of the connections of the clamping module **312** and the preheating module **316**. Since the operations of the converting modules **311** and **315** are the same as those of the converting modules **211** and **215** shown in FIG. **2**, the descriptions of the converting modules **311** and **315** are omitted.

In this embodiment, the clamping module **312** is connected to the capacitor **314** in parallel to clamp the voltage of the capacitor **314**. When the voltage of the capacitor **314** reaches a clamping level, the clamping module **312** starts working to maintain the voltage of the capacitor **314** in the clamping level. In addition, the preheating module **316** is connected to the capacitor **313** in parallel to captures the energy stored in the capacitor **313** and transfer the energy to the filaments (not shown) of the load **320**.

When the voltage of the capacitor **313** reaches a predetermined level, the preheating module **316** captures the energy stored in the capacitor **313** and transforms the energy to a preheating energy to preheat the filaments of the load **320**. At this time, the voltage of the capacitor **313** is reduced. However, the clamping module **312** limits the voltage of the capacitor **314** to avoid the voltage of the capacitor **314** being too high. Therefore, the voltage of the capacitor **314** is maintained at a stable voltage to provide a stable heating energy.

Furthermore, when the preheating module **316** does not transfer energy to the load **320**, the voltages of the capacitors **313** and **314** are not changed. Therefore, the clamping module **312** stops working, and there is no power consumption. In one embodiment, the clamping module **312** is a TVS, a surge absorber, or a MOV.

FIG. **4** is a schematic diagram of an exemplary embodiment of a connection among a converting module, a preheating module and a load, in accordance with some embodiments. As shown in FIG. **4**, the preheating module **416** comprises a DC-AC converter **431** and an isolation transformer **432**. The DC-AC converter **431** captures and converts input energy P_I to generate output energy P_O. In this embodiment, the input energy P_I is provided by a capacitor. Taking FIG. **2** as an example, the input energy P_I is the energy stored in the capacitor **214**.

The isolation transformer **432** comprises a primary winding **433**, a magnetic core **434**, and secondary windings **435~437**. The primary winding **433** is coupled to the DC-AC converter **431** to receive the output energy P_O. The secondary winding **435** is coupled to two ends of the filament **425** to preheat the filament **425**. The secondary winding **436** is coupled to two ends of the filament **421** to preheat the filament **421**. The secondary winding **437** is coupled to two ends of the filaments **424** and **426** to preheat the filaments **424** and **426**.

When the primary winding **433** receives the output energy P_O, the secondary windings **435~437** generate preheating energy to preheat the filaments **423-426**. When the converting module **415** provides the output power AC_{OUT}, the light tubes **421** and **422** are lighted quickly. Since the converting module **415** is the same as the converting module **215** or **315**, the description of the converting module **415** is omitted.

In one embodiment, the preheating module **416** operates temporarily, such as for 0.5 sec. After preheating the filaments **423~426**, the preheating module **416** stops operating. At this time, when the converting module **415** provides the output power AC_{OUT}, the light tubes **421** and **422** are lighted quickly.

FIG. **5** is a schematic diagram of another exemplary embodiment of an illumination system, in accordance with some embodiments. The illumination system **500** comprises a driving device **510** and a load **520**. The driving device **510** generates output power AC_{OUT} to drive the load **520** according to input power AC_{IN}. In this embodiment, the load **520** comprises illumination devices **521** and **522**. The illumination devices **521** and **522** are turned on according to the output power AC_{OUT}.

FIG. **6** is a schematic diagram of another exemplary embodiment of a driving device, in accordance with some embodiments. The driving device **510** comprises converting modules **511** and **515**, capacitors **513** and **514**, and clamping modules **512** and **516**. Since the operations of the converting modules **511** and **515** are the same as the operations of the converting modules **211** and **215**, the descriptions of the converting modules **511** and **515** are omitted. In this embodiment, the clamping module **512** is connected to the capacitor **513** in parallel, and the clamping module **516** is connected to the capacitor **514** in parallel.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A driving device providing output power to an illumination device comprising a plurality of filaments, comprising:

a first converting module converting input power into direct current (DC) power, wherein the first converting module comprises a pair of first input terminals receiving the input power and a pair of first output terminals coupled to a first node and a second node and outputting the DC power;

a first capacitor coupled between the first node and a third node;

a second capacitor coupled between the second and third nodes;

a first clamping module connected to a first specific capacitor in parallel, wherein the first specific capacitor is among the first and second capacitors; and

a second converting module converting the DC power to generate the output power, wherein the second converting module comprises a second input terminal pair coupled to the first and second nodes and a second output terminal pair outputting the output power to light the illumination device, wherein the first capacitor is directly connected to the second capacitor.

2. The driving device as claimed in claim **1**, wherein the first converting module is an AC-DC converter and has a power factor correction (PFC) function.

3. The driving device as claimed in claim **1**, wherein the first clamping module is a transient voltage suppressor (TVS) or a metal oxide varistor (MOV).

4. The driving device as claimed in claim **1**, wherein the capacitance values of the first and second capacitors are higher than 22 uF.

5. The driving device as claimed in claim **1**, wherein the first and second capacitors are disposed in the first converting module.

6. The driving device as claimed in claim **1**, wherein the output power is alternating current (AC) power with a high frequency.

7. The driving device as claimed in claim **1**, further comprising:

a preheating module connected to a second specific capacitor in parallel and transferring energy stored in the second specific capacitor to preheat the filament, wherein the second specific capacitor is among the first and second capacitors.

8. The driving device as claimed in claim **1**, further comprising:

a second clamping module connected to a second specific capacitor in parallel, wherein the second specific capacitor is among the first and second capacitors.

9. An illumination system comprising:

a first illumination device comprising a plurality of filaments and turned on according to output power;

a first converting module converting input power into direct current (DC) power, wherein the first converting module comprises a pair of first input terminals receiving the input power and a pair of first output terminals coupled to a first node and a second node and outputting the DC power;

a first capacitor coupled between the first node and a third node;

a second capacitor coupled between the second and third nodes;

a first clamping module connected to a first specific capacitor in parallel, wherein the first specific capacitor is among the first and second capacitors; and

a second converting module converting the DC power to generate the output power, wherein the second converting module comprises a second input terminal pair coupled to the first and second nodes and a second output terminal pair outputting the output power to turn on the illumination device, wherein the first capacitor is directly connected to the second capacitor.

10. The illumination system as claimed in claim **9**, further comprising:

a second illumination device connecting to the first illumination device in parallel and turned on according to the output power, wherein when the first illumination device is not turned on, the second illumination device is turned on according to the output power.

11. The illumination system as claimed in claim **9**, wherein the first converting module is an AC-DC converter and has a power factor correction (PFC) function.

12. The illumination system as claimed in claim **9**, wherein the first clamping module is a transient voltage suppressor (TVS) or a metal oxide varistor (MOV).

13. The illumination system as claimed in claim **9**, wherein the capacitance values of the first and second capacitors are higher than 22 uF.

14. The illumination system as claimed in claim **9**, wherein the output power is alternating current (AC) power with a high frequency.

15. The illumination system as claimed in claim **9**, further comprising:

a preheating module connected to a second specific capacitor in parallel and transferring energy stored in the second specific capacitor to preheat the filament, wherein the second specific capacitor is among the first and second capacitors.

16. The illumination system as claimed in claim **9**, further comprising:

a second clamping module connected to a second specific capacitor in parallel, wherein the second specific capacitor is among the first and second capacitors.

* * * * *